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Economic and Physical Impacts on Individual Farm Management Units Under Alternative Management Scenarios in the Blue Creek Watershed, Pike County, Illinois

Illinois State Environmental Protection Agency
Springfield

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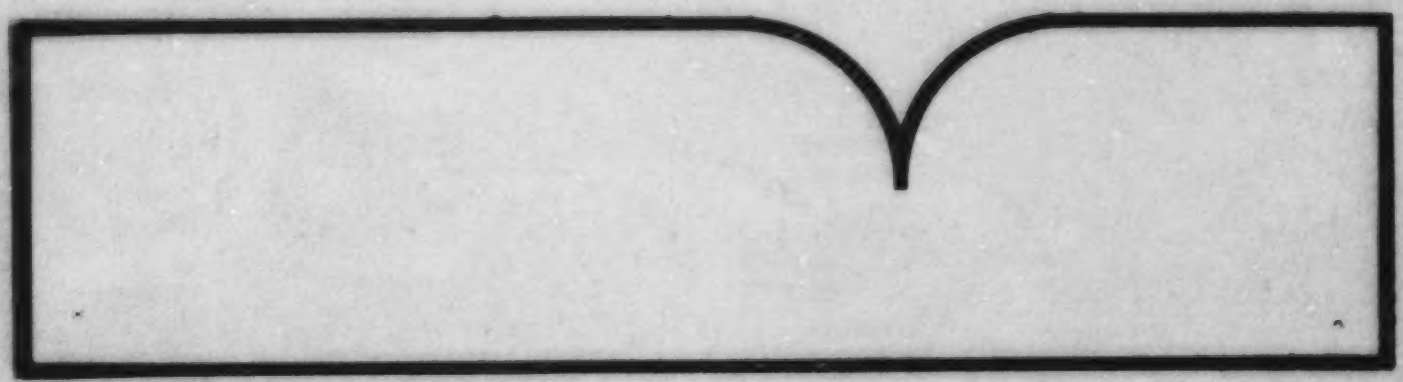

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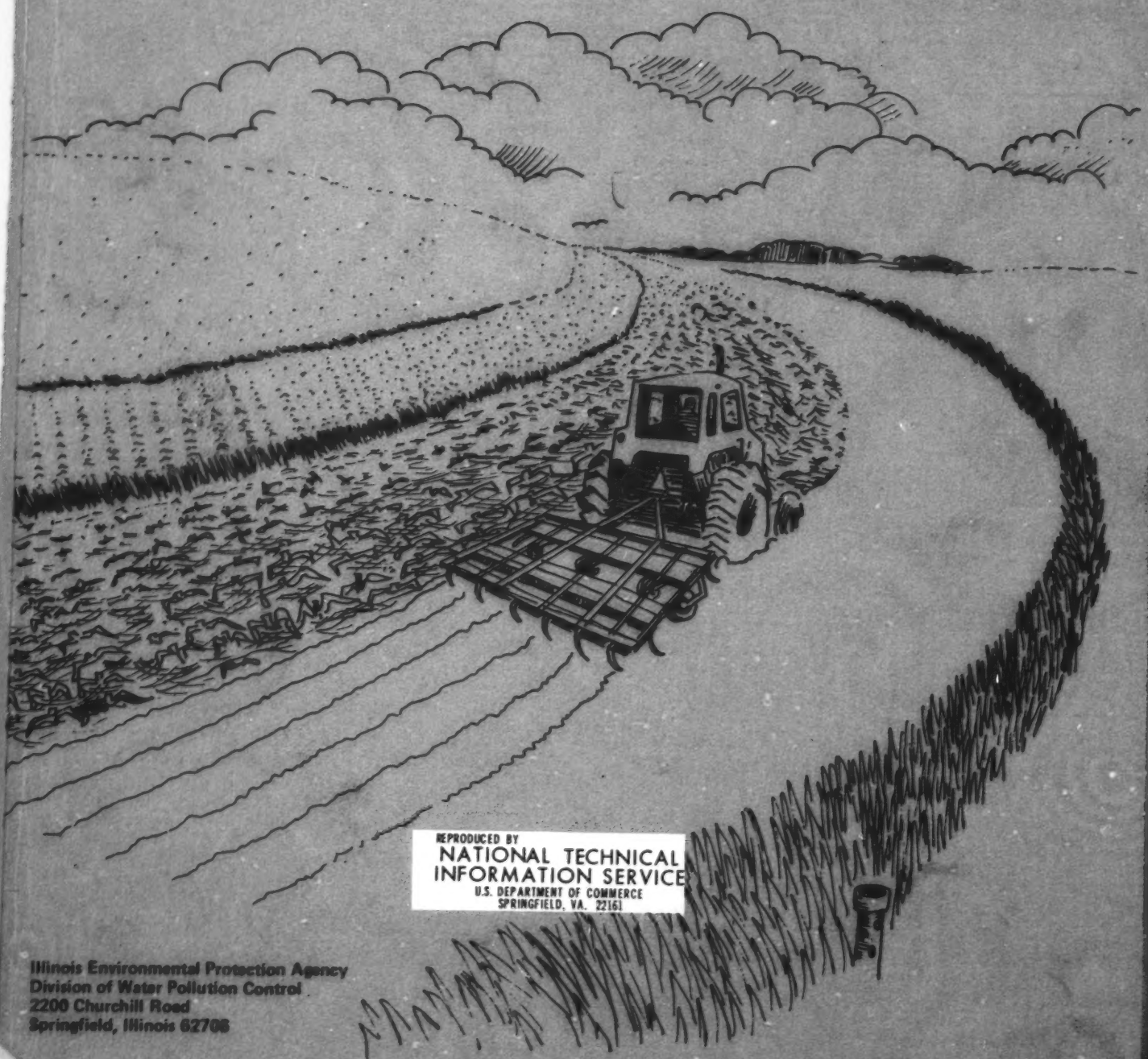

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This study is concerned with the effects of Resource Management Systems upon the annual net production value and soil erosion of individual land management units under three different management conditions. In comparison to the existing condition, the attainable and future scenarios exhibited five major trends in time. These five trends are: 1) an increase in the number of negative annual net production value land management units, 2) a significant increase in the number of land management units with conservation practices and some form of conservation tillage, 3) a slight increase in rotation length, 4) no major land use shifts between, and 5) a decrease in total erosion. ADAPT a geo-based computer mapping and planning system was used.

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July, 1982

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The guidance and assistance provided by the United States Department of Agriculture -- Soil Conservation Service (SCS) under the direction of State Conservationist Warren J. Fitzgerald and John J. Eckes is gratefully acknowledged. Specifically, Ron Murphy, Wayne Kinney, Edward Johnston, William Lewis, Harvey Sundmacker, and Keith Donelson of the SCS were very helpful. Dick Thom of the Illinois Department of Conservation assisted in determining the revenue information concerning woodlands utilized in this project.

Portions of this report were taken from a report prepared for the Illinois Environmental Protection Agency (IEPA) concerning gross erosion in the Blue Creek Watershed by W.E. Gates and Associates, Inc. (1981).

Rodney Mutz and Julie J. Oehme of IEPA provided technical assistance throughout this project. The guidance and editorial comments of Bill Lewis, John Lowrey (SCS), Robert Clarke, and William Rice (IEPA) were appreciated. Gloria Ferguson created the cover. W.E. Gates and Associates supplied Figures 2-5. This report was typed by the Word Processing II Unit under the direction of Norma Kraus.

Executive Summary

1. Background: The Illinois Environmental Protection Agency (IEPA) in cooperation with the United State Department of Agriculture Agencies, Agricultural Stabilization and Conservation Service (ASCS), Illinois Cooperative Extension Service (ICES) and Soil Conservation Service (SCS), is evaluating the impact of Resource Management Systems (RMS's) implemented under the Agricultural Conservation Program Special Water Quality Project in the Blue Creek Watershed; Pike County, Illinois. The primary objective of this project is to identify the most viable agricultural non-point source (NPS) control strategy, demonstrate its effectiveness and develop a methodology to identify land causing water quality problems and to determine the appropriate RMS's.

2. Investigation: This study is concerned with the effects of RMS's upon the annual net production value and soil erosion of individual land management units. A land management unit is defined as a unit of area that is under uniform management. Three different management conditions were defined for each land management unit in the project area: 1) existing, 2) attainable (planned to be implemented as part of the ACP -- Special Water Quality project) and 3) future (as estimated locally as to what was most likely to be there long term). Land use/cover was delineated by individual field boundaries for this analysis. For each field in a row crop, the rotation, tillage system and conservation practice were defined. The watershed chosen for this investigation was the Blue Creek Watershed located in east central Pike County, Illinois.

3. Systems: The ADAPT (areal design and planning tool) is a geo-based computer mapping and planning system. This system was utilized to determine potential gross erosion and annual net production value for the specified management conditions.

4. Results: In comparison to the existing condition, the attainable and future scenarios exhibited five major trends in time. These five major trends are: (1) an increase in the number of negative annual net production value land management units within the watershed, (2) a significant increase in the number of land management units with conservation practices and some form of conservation tillage, (3) a slight increase in rotation length, (4) no major land use shifts between conditions, and (5) a decrease in total erosion.

This study demonstrated how the ADAPT system provides a way for estimating program costs and the need for cost-share funds. In addition to this, it also provides a way to test and compare potential management strategies at the field level scale.

Introduction

The Federal Clean Water Act Amendments of 1977, Public Law 95-217, has mandated pollution abatement efforts be directed toward controlling pollutants at their sources rather than after the pollutant has entered the watercourse. The "208" planning process has placed the emphasis on nonpoint pollutant control.

Nationwide, agriculture is the most widespread cause of nonpoint source pollution. Initial "208" water quality planning efforts documented that agricultural activities are a significant source of pollution in Illinois (IEPA, 1979). A severe agricultural related problem is soil erosion resulting in particulate transport. To control agricultural nonpoint source pollution, effective and efficient land management practices and programs must be developed and implemented.

This study is concerned with the effects that Resource Management Systems (RMS's) would have upon the annual net production value of individual land management units and the resulting soil erosion. Three different management conditions were defined for each land management unit in the project area: existing, attainable (planned to be implemented as part of the Agricultural Conservation Program-Special Water Quality Project) and future (defined by the local Conservation Facility as to what was most likely to be there long term). Future management condition includes ACP Special Water Project and continuation of ongoing program at pre-project rate of application. The attainable and future conditions are projected management activities where implementation depends upon numerous uncontrollable factors. The watershed chosen for this investigation was the Blue Creek Watershed located in east central Pike County, Illinois (Figure 1).

Soil Erosion and its Control

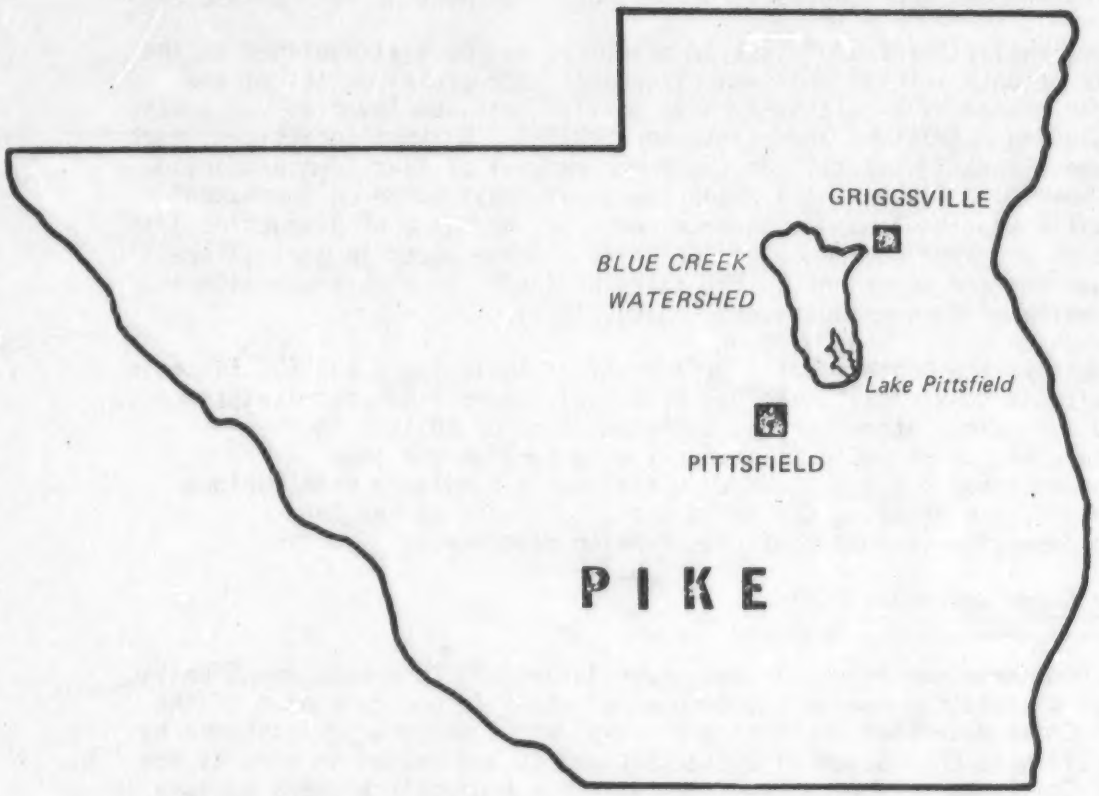
Soil erosion has several observable consequences: 1) sites of origin of eroding soil particles are degraded and thus potential productivity is lessened because of erosion; 2) sites of deposition of soil particles are altered physically, chemically and hydrologically, and 3) the environment of the transporting water system is altered drastically in terms of its physical and chemical nature. None of these effects are presently being evaluated as part of this project.

Geologic weathering occurs when the rate of erosion is in balance with climate, vegetation and other factors of the natural environment. Accelerated erosion is induced by man's activities or natural catastrophies and causes soil loss to occur at an excessive rate. Agricultural activities disturb the normal balance of geologic erosion and vegetative cover which can result in higher rates of erosion.

Absolute economic values associated with the effects of soil erosion are extremely difficult to assess. Degradation of the productive capacity of agricultural land results in decreased yield. Without doubt, the most serious consequence of erosion is its degrading effects on the aquatic environment. Obviously, the physical and economic consequences of off-site damages due to soil erosion are substantial.

RMS's that would reduce soil erosion to more tolerable losses can be implemented by the individual land owner/operator. Reducing soil erosion on the individual land management units should reduce off-site damages associated with soil loss from agricultural practices.

Figure 1: Blue Creek Watershed, Pike County, Illinois



RMS's can be divided into two groups. The first, cultural practices, are nonstructural in nature. This group includes conservation tillage systems, contouring and stripcropping. The second group consists of structural practices which usually require off-farm equipment for construction. The practices in this group include terraces, diversions, grassed waterways, lagoons and filter strips.

The basic principle of these RMS's are to alter the runoff, provide cover for soil or change the water absorption capacity of soil, rain splash energy, and soil structure. Most RMS's are designed to control either, (1) detachment and transport, or (2) only transport of soil particles.

Economically, the two classes of practices can be distinguished on the basis of both initial and recurring cost. Structural practices are characterized by a relatively high initial cost and lower annual costs (including operations and maintenance costs). Cultural practices, such as the alteration of tillage system or removal of land from production for some purpose, having a recurring annual cost based on increased annual operations and maintenance costs or the value of production lost through the application of the practice. These costs in agricultural situations are dependent on the costs of inputs to farm production and the value of farm products sold (Lake, 1977).

Presently, the United States Department of Agriculture and the Illinois Department of Agriculture offer technical and/or financial assistance to land owners/operators for the implementation of RMS's. The implementation of RMS's is strictly voluntary on the land owner/operator's part. Even with assistance available from various agencies, the deciding factor is the willingness of the land owner/operator to implement conservation practices.

Blue Creek Watershed Project

The "Economic and Physical Impacts on Individual Farm management Units Under Alternative Management Scenarios" study is one component of the Blue Creek Watershed monitoring and evaluation project administered by the Illinois Environmental Protection Agency and funded in part by the U.S. Environmental Protection Agency. This project's primary purpose is to determine the actual yield of pollutants from a variety of agricultural practices to downstream receiving water and their effects upon the water quality and reasonable uses of the water resources. Monitoring and evaluation of actual RMS implementation progress on fields and sub-watersheds will provide a reliable comparison of low and high cost practices on downstream yield reductions. Evaluation of cause and effect relationships of practices will determine the non point source pollution yields from farmland and the impact of RMS's on both stream and lake quality. The objective of this study was to determine annual net production value and annual erosion from individual fields under the three management scenarios in the Blue Creek Watershed. For a complete description of the Blue Creek Watershed project, refer to "Blue Creek Watershed Project, Pike County, Illinois, May, 1979 - October, 1980" (Davenport, 1981).

Study Area

The Blue Creek watershed encompasses slightly more than 7,000 acres in east central Pike County, Illinois. Terrain is hilly, when compared with most areas in Illinois and it has a high soil loss potential due to its steep slopes, fine-textured soils and agricultural land use practices (Figure 2, Table 1). The Blue Creek watershed drains into Pittsfield City Lake, which was constructed in 1961. Average annual soil loss is estimated at 9.0 tons/acre/year (Davenport, 1982). Erosion from livestock operations (primarily hogs) contributes to the total basin sediment load.

Table 1. Land Use and Crop Distribution in the Blue Creek Watershed as of October 1, 1980 in acres (Davenport, 1982).

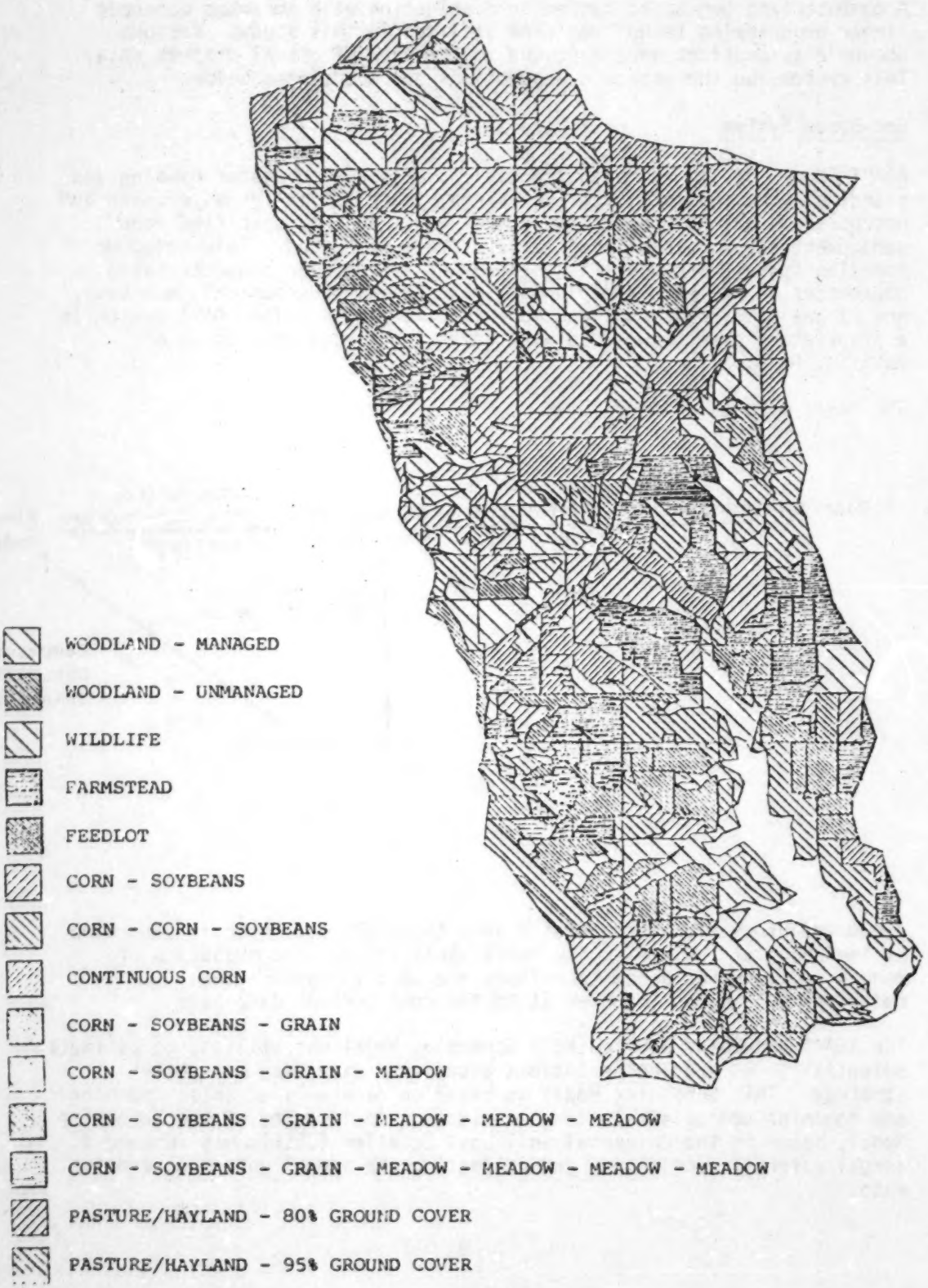
		Total
Cropland		
Corn	1890.1	
Soybeans	853.2	
Small Grains	368.0	
Meadow	849.5	
Subtotal		3960.8
Pasture/Hayland*		
80% cover	731.3	
95% cover	788.0	
Subtotal		1519.3
Woodland		
Managed	543.6	
Unmanaged**	266.4	
Subtotal		810.0
Other		
Wildlife	311.7	
Farmstead	109.1	
Feedlot	65.5	
Water	236.4	
Subtotal		722.7
TOTAL		7012.8

*Includes grass waterways.
**Livestock grazing permitted.

Table 2. Crop rotations in the Blue Creek Watershed as of October 1, 1980 in acres (Davenport, 1982)

Crop Rotation	# of Acres
C-Sb	760.2
C-C-Sb	315.5
Continuous C	931.7
C-Sb-Gr	129.5
C-Sb-Gr-M	466.1
C-Sb-Gr-M-M-M	601.3
C-Sb-Gr-M-M-M-M	756.5
Total	3960.8

Figure 2: Existing Land Use/Cover Conditions as of October 1, 1980


WOODLAND - MANAGED
WOODLAND - UNMANAGED
WILDLIFE
FARMSTEAD
FEEDLOT
CORN - SOYBEANS
CORN - CORN - SOYBEANS
CONTINUOUS CORN
CORN - SOYBEANS - GRAIN
CORN - SOYBEANS - GRAIN - MEADOW
CORN - SOYBEANS - GRAIN - MEADOW - MEADOW - MEADOW
CORN - SOYBEANS - GRAIN - MEADOW - MEADOW - MEADOW - MEADOW
PASTURE/HAYLAND - 80% GROUND COVER
PASTURE/HAYLAND - 95% GROUND COVER

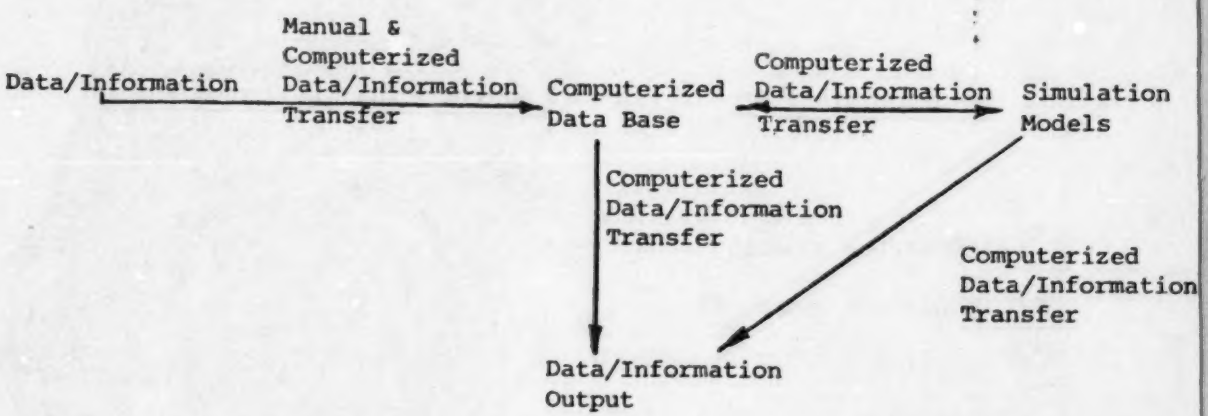
Methodology

A computerized geo-based system in combination with accepted economic linear programming techniques were utilized in this study. Various economic assumptions were made due to the lack of actual project data. This system and the economic assumptions are documented below.

Geo-Based System

ADAPT (areal design and planning tool) a geo-based computer mapping and planning system was utilized for determining potential gross erosion and potential annual net production value resulting from specified land management activities within the Blue Creek watershed. This computer modeling system represents a synthesis of two popular computer based approaches to analysis and planning, 1) spatial/geographical data base, and 2) analytical/mathematical modeling techniques. The ADAPT system is a proprietary system owned by W.E. Gates and Associates, Inc., of Batavia, Ohio.

The basic modules of ADAPT are:



The data/information incorporated into the ADAPT data base is determined by the needs of the particular ADAPT application. A combination of manual and computer based techniques are used to capture the data/information and transfer it to the computerized data base.

The ADAPT Non-Point Source (NPS) Screening Model was utilized to estimate potential gross erosion conditions associated with each management strategy. This Screening Model is based on generally accepted hydrologic and nonpoint source simulation techniques. Application of the Screening Model, based on the Universal Soil Loss Equation (USLE), was focused at annual rainfall conditions, and estimating the annual potential erosion rate.

The accuracy of the ADAPT NPS Screening Model was field verified on a representative field in the northwestern section of the watershed owned by Dwight Dunham. Edward Johnston, Soil Conservationist-SCS, made the necessary measurements and USLE calculation. The field calculation estimated erosion to be 24 tons/acre/year. The ADAPT model estimated erosion to be 22.3 tons/acre/year. The 7% difference results from of the determination length-slope (LS) factor. "The LS factor is particularly sensitive to errors in measuring average slope because these errors are magnified in calculating LS for slopes above about 3 percent. Errors in measuring the average slope length are not as critical because they are reduced by half or more in calculating LS (Williams and Berndt, 1977)." The ADAPT model calculates the percent slope and uses an average slope-length factor for each soil series, whereas the field calculation incorporates actual field measurements (Davenport, 1982).

The USLE was designed to predict field sheet and rill erosion in tons/acre on an average annual basis and does not predict sediment delivery to streams. The USLE (United States Department of Agriculture, 1977) is applicable to cropland, pasture, woodland, wildlife land, and idle land (see Wischmeier and Smith, 1965, for development and use). The soil loss prediction formula is as follows: A = RKLSCP where A is the average annual soil loss in tons per acre predicted by the equation.

R: the rainfall and runoff factor, is the number of rainfall erosion index units, plus a factor for runoff from snowmelt or applied water where such runoff is significant.

K: the soil erodibility factor is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as a 72.6 ft. length of uniform 9% slope continuously in clean tilled fallow.

L: the slope-length factor, is the ratio of soil loss from the field slope length to that from a 72.6 ft. length under identical conditions.

S: the slope-steepness factor, is the ratio of soil loss from the field slope gradient to that from a 9% slope under otherwise identical conditions.

C: the cover and management factor, is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow.

P: the support practice factor, is the ratio of soil loss with a support practice like contouring, stripcropping, or terracing to that with straight-row farming up and down the slope.

United States Geological Survey, 7 1/2 minute maps provided the topographical and political boundaries, soils data was provided by SCS. Land cover/use in fourteen categories was furnished by IEPA and SCS from aerial photos and ground surveys. Land cover/use was delineated by individual management unit boundaries. For each land management unit, three management scenarios were specified: 1) existing conditions, 2) attainable, as part of the USDA-ACP Special Water Quality Project, and 3) future conditions as estimated to occur locally. A list of the crop rotations, tillage systems, and conservation practices making up these management practices for the land management units in the watershed is presented in Tables 2 and 3. The data base cell size ranged from 0.06 to 8.19 acres (average = 0.88 acre) for the completed data base.

USLE factors: cover (C) and conservation practice (P) were provided by the local SCS District Conservationist. This information is listed in the Appendix Section. Slope length, also obtained from SCS, was a representative slope length for each soil series. The percent slope was calculated by the ADAPT system. The soil erodibility factor and the rainfall factor were obtained from Resource Conservation Planning Technical Note IL-4 (USDA-SCS, 1977). Each management scenario had the effect of changing the land cover/use, cropping practice or slope-length factors for the USLE computations. Calculation of potential gross erosion under these various scenarios gives a general idea of the relative effectiveness of these specified practices in this watershed.

Table 3. List of Cropping and Tillage Systems

Cropping Systems

- Corn - Soybeans
- Corn - Corn - Soybeans
- Corn - Soybeans - Grain
- Corn - Soybeans - Grain - Meadow
- Corn - Soybeans - Grain - Meadow - Meadow - Meadow
- Corn - Soybeans - Grain - Meadow - Meadow - Meadow - Meadow - Meadow

Tillage Practices

- Moldboard Plow --- Spring
- Moldboard Plow --- Fall
- Chisel Plow --- 1 - 2000 lbs. residue
- Chisel Plow --- 2 - 3000 lbs. residue
- Chisel Plow --- 3 - 4000 lbs. residue
- No-till --- 1 - 2000 lbs. residue
- No-till --- 2 - 3000 lbs. residue
- No-till --- 3 - 4000 lbs. residue
- No-till --- 4 - 6000 lbs. residue

Table 4. List of Conservation Practices

Conservation Practices

- Contouring
- Terraces
- Stripcropping
- Pasture Seeding or Critical Area Seeding
- Livestock Exclusion
- Animal Waste System

Economic Considerations

This study evaluates cost and effects of RMS's when implemented on individual farm management units. The primary objective of this section is to detail the productivity and cost assumptions; and the method utilized in calculating annual net production value.

Productivity

The productivity of land is a function of soil properties, management, and climate. Management is defined as the selection and application of crop production technology. "Soil productivity is strongly influenced by the capacity of a soil to supply the nutrient and soil-stored water needs of a growing crop in a given climate. Productivity also depends in part upon the adaption of a particular crop to specific growing conditions and level of management," (Fehrenbacher, et al., 1978). The productivity of a management unit is reflected by the product yield relationship for the soils of that unit, expressed in terms of unit of measure/acre/year.

The basic productivity information utilized in this study was obtained from "Soil Productivity in Illinois," Circular 1156 developed by the Illinois Cooperative Extension Service (Fehrenbacher, et. al., 1978). Circular 1156 is a guide to the relative productivity of Illinois soils and average yields under assumed management levels. The basic crop yield data utilized in this study is shown on Table 4. For row-crop, basic yield relationships were developed as a function of soil series and were based on uniform conditions of uneroded soils at 0-2 percent slopes and high management levels. Table 5 shows the percentage adjustments in yield under high and basic levels of management, slope groups, and erosion conditions. The basic level of management includes minimum inputs considered necessary for crop production to be feasible. The high level of management includes inputs that are near those required for maximum production capacity with current technology.

Productivity estimates were developed for row-crop fields, pasture/hayland, and woodland areas. No estimates were made for feedlots, farmsteads or wildlife areas. The relationships used for calculating yields for pasture/hayland and woodland areas are shown on Table 6.

Table 5. Row-Crop Yield Relationships

Crop Yields Per Acre (Uneroded Conditions, 0-2% Slope)

CROP/ SOIL	High Level of Management			Basic Level of Management		
	Corn	Soybeans	Wheat	Corn	Soybeans	Wheat
	(bushels per acre)					
Hickory	80	26	29	36	13	13
Atterberry	149	44	60	94	30	32
Clinton	129	39	53	79	23	26
Fayette	129	39	53	79	23	26
Rozetta	131	40	54	82	23	26
Muscatine	167	51	64	104	33	34
Keoman	129	39	52	82	24	28
Tama	155	46	62	100	32	36
Downs	148	43	59	92	31	33
Clarksdale	140	43	57	94	30	31
Hammond	140	45	60	88	26	31
Stronghurst	138	42	55	85	25	29
Orion	135	43	52	82	28	28
Sable	156	51	61	103	34	32
Wakeland	135	45	57	83	26	29
Sylvan	112	35	53	63	19	22
Drury	126	40	57	89	26	29
Blair	95	33	44	49	17	22
Rushville	114	36	47	64	20	23

Table 6. Percentage adjustments in yield under high and basic levels of management, slope groups, and erosion conditions

(SLOPE PERCENT)	HIGH MANAGEMENT			BASIC MANAGEMENT		
	UN-ERODED	MODERATE EROSION	SEVERE EROSION	UN-ERODED	MODERATE EROSION	SEVERE EROSION
		(PERCENT)			(PERCENT)	
0-2...	100	97	90	100	95	85
2-5...	99	96	89	98	93	83
5-10...	97	94	87	95	90	80
10-15...	93	90	83	90	85	75
15-20...	87	84	77	84	79	69
20-25...	80	77	70	77	72	62
25-30...	71	68	61	68	63	53
30-35...	60	57	50	57	52	42
35-40...	52	49	42	49	44	43
40+...	48	45	38	45	40	30

NOTE: All soils in Blue Creek are associated with favorable subsoils. See "Soil Productivity in Illinois," University of Illinois, College of Agriculture Cooperative Extension Service, Circular 1156, 1978.

Table 7. Non Row-Crop Yield Relationships

CROP SOIL	Crop Yields Per Acre (Uneroded Conditions, 0-2% Slope) HIGH LEVEL OF MANAGEMENT HAY (tons/ac)	PASTURE (days/ac)	BASIC LEVEL OF MANAGEMENT HAY (tons/ac)	PASTURE (days/ac)	WOODLAND[1] (board ft/ac)
Hickory	3.0	150	1.4	70	225
Atterberry	5.6	280	3.5	175	500
Clinton	5.2	260	3.2	160	350
Fayette	5.2	260	3.2	160	400
Rozetta	5.2	260	3.2	160	400
Muscatine	6.2	310	4.0	200	555
Keomah	5.1	255	3.0	150	300
Tama	5.9	295	4.0	200	400
Downs	5.6	280	3.6	180	375
Clarksdale	5.3	265	3.5	175	500
Haymond	5.3	265	3.3	165	500
Stronghurst	5.3	265	3.2	160	350
Orion	4.7	235	3.0	150	500
Sable	5.6	280	3.5	175	425
Wakeland	5.2	260	3.1	155	575
Sylvan	5.0	250	2.4	120	325
Drury	5.0	250	3.4	170	225
Blair	3.7	185	2.2	110	200
Rushville	4.2	210	2.2	110	250

[1]"Woodland" assumes deciduous forest.
Note: 50 pasture-days equals 1 ton of hay

Costs

Capital, operating and production costs of each type of land management activities were estimated. The following assumptions were made:

1. Capital costs were only assigned when a new conservation practice was instituted on a field. Capital costs were based on 1979-1980 project averages.

2. The functional life of the improvements were equal to the period of economic analyses (10 years), which eliminated the need to consider replacement and/or resale costs. Structure life expectancy varies due to type of structure, maintenance, and cliamtic conditions. Terraces normally are considered to have a longer useful economic life with proper maintenance; i.e. 20-25 years.

3. Structural practices' design life of ten (10) years and an interest rate of twelve percent (12%) was used. The rate currently used by Federal agencies in Water Resource Project activities is 7.63%.

Implementation costs for the conservation practices that were applied to row-crop management units are presented in Table 7. For each conservation practice, a one-time capital cost and an annual operation and maintenance (O&M) cost were identified. These estimated costs are based on land owner/operator costs resulting from implementing conservation practices as part of the ACP Special Water Quality Project. These costs were provided by Edward Johnston, Soil Conservationist in Pike County. These costs are expressed on a "per acre" basis with the exception of livestock exclusion (i.e., fencing) which is expressed on a "per foot" basis. Capital costs were "annualized" using standard economic methods, design life and interest as stated in the assumptions, and are combined with annual O&M costs to determine a total annualized cost.

Table 8. Row-crop conservation practice costs

CONSERVATION PRACTICE	CAPITAL COST PER ACRE	ANNUAL O&M COST $/ACRE/YR	TOTAL ANNUALIZED COSTS $/ACRE/YR	
			10 YEAR AT 10%	20 YEAR AT 12%
Contouring	0	$6.00	$6.00	$6.00
Terraces*	$350.00	$17.50	$79.45	$64.50
Stripcropping	0	$6.00	$6.00	$6.00
Pasture Seeding or Critical Area Seeding	0	$80.00	$80.00	$80.00
Livestock Exclusion**	$1.70	$.10	$0.40	$0.33
Animal Waste System	$8000.00	$1500.00***	$2916.00	$2,570.00

*Parallel tile outlet with broad base.
**Livestock Exclusion Costs are per foot of perimeter of the field, calculated automatically from ADAPT based on field boundaries stored therein.
***Removal of waste from system to place of conveyance.

Table 9A. Estimated production costs (Basic level management)

Cropping System	Mold. Plow-Spring	Mold. Plow-Fall	Chisel Plow 1-2000# RES	No-till 1-2000# RES
	(dollars/acre/yr.)			
C-Sb	140.58	140.58	133.06	92.29
C-C-Sb	153.61	153.61	145.82	95.22
Continuous Corn	179.68	183.68	171.34	101.09
C-Sb-Gr	119.46	119.46	109.05	86.40
C-Sb-Gr-Meadow	114.60	114.60	106.08	81.88
C-Sb-Gr-M-M-M	109.73	109.73	104.52	90.93
C-Sb-Gr-M-M-M-M-M	108.34	108.34	103.87	92.33

Table 9B. Estimated production costs, high level management

Cropping System	Chisel Plow 2-3000# RES	Chisel Plow 3-4000# RES	No-till 2-3000# RES	No-till 3-4000# RES	No-till 4-6000# RES
	(dollars/acre/yr.)				
C-Sb	159.15	159.15	92.29	116.44	116.44
C-C-Sb	175.88	175.88	95.22	123.27	123.27
Continuous Corn	209.36	209.36	101.09	136.94	163.71
C-Sb-Gr	126.45	126.45	86.40	96.92	96.92
C-Sb-Gr-Meadow	119.84	119.84	81.88	97.69	97.69
C-Sb-Gr-M-M-M	113.22	113.22	90.93	98.46	98.46
C-Sb-Gr-M-M-M-M-M	111.29	111.29	92.33	98.68	98.68

Estimated production costs are shown in Tables 9A and B. Costs delineated in Tables 9A and B were provided by Bill Lewis of the SCS-Watershed Unit in Champaign, Illinois. These costs were obtained from crop budgets developed using the SCS Crop Budget System based on 1980 data. The estimated production costs included, if necessary: fuel, fertilizers, herbicides and repairs, etc. The estimated production costs shown in Tables 9A and B, were applied to row-crop fields and pasture areas only; no production costs have been assigned to woodland areas, wildlife areas, farmsteads, or feedlots.

The total estimated production cost per acre for any given field was developed by summation of the appropriate conservation practice cost/acre, and estimated production cost as developed from data shown in Tables 8-9. The resulting total cost/acre was then multiplied by the number of acres in the land management unit to obtain total costs. No management or land charges were generated or included in this analysis.

Annual Net Production Value Calculation

Revenue information that was assigned to total production on row-crop fields, pasture/hayland and woodland areas is shown in Table 10. The current normalized prices which are used in traditional SCS project analysis are included in Table 10. Corn, soybean and wheat revenue information were the prices posted at the Federal grain elevator on July 16, 1981. The revenue information concerning hay and timber was provided by the Pike County Soil and Water Conservation District and Illinois Department of Conservation, respectively, on July 16, 1981.

Table 10. Revenue Assumptions and Current Normalized Prices

CROP	DOLLAR VALUE	CURRENT NORMALIZED PRICES* (1981)
#2 yellow corn	$3.21/bushel	$2.78/bushel
#1 yellow soybeans	$7.21/bushel	$6.93/bushel
new crop soft wheat	$3.36/bushel	$3.45/bushel
hay	$42/ton	$61.16/ton
timber	5.5¢/board foot	5¢/board foot

*Water Resource Council

The productivity of a management unit is expressed in terms of unit of measure/acre/year. Using a specified cash value for each unit of crop produced, the average annual production for each management unit can be estimated.

Annual net production value income is defined as the difference between average annual production value and total production cost and/or treatment cost per acre.

Results

The information presented here deals with reductions in soil loss rather than improvements in water quality. Table 11 summarizes the potential soil erosion estimates for the three management scenarios. Figures 3, 4 and 5 depict the location and severity of potential soil erosion under existing, attainable, and future conditions, respectively.

In comparison to the existing condition, the attainable and future scenarios exhibited five major trends. These five major trends were: (1) an increase in the number of negative annual net production value land management units within the watershed (Table 12), (2) there is a significant increase in the number of land management units with conservation practices and some form of conservation tillage, (Tables 14 and 15), (3) a slight increase in crop rotation length, (4) no major land use shifts between scenarios (Table 11), and (5) a significant decrease in total erosion (Table 11).

Table 11. Acres, average erosion, percent of the total erosion by land use/cover for the three specified management scenarios. (Gates, 1981)

Land Use/ Crop Type	EXISTING CONDITION No. of Acres	Erosion (Tons/Acre)	Percent of Total Erosion	ATTAINABLE CONDITIONS No. of Acres	Erosion (Tons/Acre)	Percent of Total Erosion	FUTURE CONDITIONS No. of Acres	Erosion (Tons/Acre)	Percent of Total Erosion
C-S	760.2	26.0	31.47	447.6	9.4	13.68	342.7	5.1	8.41
C-C-S	315.5	22.0	11.05	315.5	8.6	8.28	258.9	7.5	9.38
Continuous Corn	931.7	15.6	23.14	1163.8	9.6	34.34	1117.1	6.8	36.77
C-S-G	129.5	14.4	3.07	217.4	6.9	4.63	238.9	4.4	5.02
C-S-G-M	466.1	8.6	6.40	410.0	4.5	5.70	456.3	2.9	6.28
C-S-G-M-M-M	601.3	7.3	6.96	616.8	4.7	8.83	688.1	2.8	9.26
C-S-G-M-M-M-M	756.3	5.8	6.98	759.7	3.9	9.05	792.2	2.8	10.71
Past/Hay 80% Cover	731.3	1.9	2.24	497.5	2.1	3.14	83.0	1.4	0.55
Past/Hay 95% Cover	788.0	0.3	0.37	1061.7	0.3	1.02	1546.5	0.4	2.73
Woodland-Managed	543.6	0.6	0.49	647.8	0.6	1.15	811.3	0.6	2.30
Woodland-Unmanaged	266.4	8.9	3.77	164.9	8.7	4.4	1.4	3.46	0.02
Wildlife	311.7	0.4	0.14	283.9	0.4	0.33	283.9	0.4	0.52
Farmstead	109.1	1.1	0.14	109.1	1.1	0.36	109.1	1.1	0.57
Feedlot	65.5	35.5	3.70	50.7	32.67	5.08	46.8	33.1	7.41
Water	236.4	0	0	236.4	0	0	236.4	0	0
TOTAL	7012.8	9.0	100	7012.8	4.7	100	7012.8	3.2	

C: Corn; S: Soybean; G: Grain; M: Meadow

Table 12. Number of negative net production value land management units by practice and scenario as estimated by the ADAPT system*.

Land Use/Practice	Existing	Attainable	Future
Woodland w/Livestock Exclusion	20	38	39
Wildlife w/Livestock Exclusion	19	26	25
Pasture-Hayland Critical Area Seeding	41	95	105
Pasture-Hayland	5	3	3
Feedlot/Animal Waste System	5	19	16
Cropland/Contour-3000# Residue	0	1	0
Pasture/Terraces	0	0	2
Total	91	182	190

*These are relative comparisons due to the basic assumptions described in the preceeding section on economic considerations.

Figure 3

BLUECREEK LANDUSE CONDITIONS

A
EXISTING

B
ATTAINABLE

C
ULTIMATE

- WOODLAND - MANAGED
- WOODLAND - UNMANAGED
- WILDLIFE
- FARMSTEAD
- FEEDLOT
- CORN - SOYBEANS
- CORN - CORN - SOYBEANS
- CONTINUOUS CORN
- CORN - SOYBEANS - GRAIN
- CORN - SOYBEANS - GRAIN - MEADOW
- CORN - SOYBEANS - GRAIN - MEADOW - MEADOW - MEADOW
- CORN - SOYBEANS - GRAIN - MEADOW - MEADOW - MEADOW - MEADOW
- PASTURE/HAYLAND - 80% GROUND COVER
- PASTURE/HAYLAND - 95% GROUND COVER

Discussion

Annual net production value calculations for any of the scenarios did not take into consideration changes in yield or off-site benefits resulting from the implementation of the specified RMS's. Haith (1979) postulates that the implementation of RMS's would generally not have an impact on yield or would result in an increased yield. He bases this on a review of the current literature.

The significance of land management units with a negative net production value is relative. Land charges were not included in the net income calculation nor were cost-share funds or tax assessments. Crop management and yield information for the net production value calculations were based upon statewide averages, not watershed specific information. Estimated production costs were based on 1980 information, revenue values were based on 1981 and total annualized costs were based on 1979-1980 project information.

There is an increase in number of land management units with a negative net production value between existing conditions and the two projected scenarios. There is a 100% increase in the number of land management units with negative net income from the existing conditions (91) to the attainable condition (182). The increase in negative net production value land management units between existing conditions (91) to future (190) is 108%.

The largest land use/cover category of land showing an income loss is pasture/hayland units with critical area seeding (Figures 3 and 4). This increases from existing condition's 47% to 51.6% of the attainable condition's net negative production value units and 54.4% of the future condition's net production value units. In the net production value calculation, no adjustment in yield due to increased ground cover is included. This is a partial analysis since it reflects only increases in costs and due to conservation benefits. The second and third largest land cover/use categories among negative net production value land management units are woodland and wildlife areas that have had livestock exclusion practices implemented. The wildlife land cover/use category has no yield associated with; in essence, it is a sink because just the cost of implementing the livestock exclusion practice (fencing) is included in the net income calculation. Woodland land use categories did not generate an annual income in this analysis, so its inclusion in the negative net income category is misleading.

There was one cropland management unit with a negative net value under the projected attainable conditions; 1) continuous corn -- chisel plow -- 3000# residue on the contour ($0.68/ac). This results from higher management or higher yield level and the associated estimated production costs on a field which lacks the production potential.

Table 13. Number of cropland management units by tillage system for each scenario.

	Existing	Condition Attainable	Future
Chisel -- 2000 lbs	57	18	14
Chisel -- 3000 lbs	32	123	58
No-Till -- 2000 lbs	0	0	2
No-Till -- 3000 lbs	0	1	0
No-Till -- 4000 lbs	7	20	42
No-Till -- 6000 lbs	7	34	82
Moldboard Spring	75	18	10
Moldboard Fall	38	1	1

Table 14. Number of cropland management units and conservation practice for each scenario.

	Existing	Condition Attainable	Future
Total Cropland Units	216	215	194
Acres			
Contour	26	100	71
Terraces	11	26	52
Stripcropping	0	1	17

Figure 4

BLUECREEK EROSION RATES

A
EXISTING

B
ATTAINABLE

C
ULTIMATE

WATER/WETLANDS
LESS THAN 2.95 TONS/ACRE/YEAR
BETWEEN 2.95 AND 8.97 TONS/ACRE/YEAR
GREATER THAN 8.97 TONS/ACRE/YEAR

There is little difference in rotation length between existing conditions and those attainable under the ACP Special. There is a 2.5% decrease in the amount of cropland that is managed on a 3 year or less rotation between the existing conditions and the predicted future condition. Cropland that is managed on a 4 year or greater rotation increases 1.5%, this increase occurs on steeply sloping lands.

There were no major land use changes between scenarios (Figures 3: A, B and C). The amount of area in pasture/hayland and woodland categories only gained 1.7% and 0.7%, respectively. The amount of area in feedlot operations decreased 28% over the scenario period (existing to future), this is insignificant in terms of actual acreage. Instead there were significant changes in management patterns. Pasture/hayland 80% cover was 10.4% under existing conditions shifted to only 1.2% under ultimate conditions. Pasture/hayland area with 95% cover increased by almost 10% for the same periods. The woodland land use/cover category exhibited a similar trend toward a higher degree of management. The principal difference between managed and unmanaged woodland areas in the Blue Creek Watershed is unmanaged areas are used for livestock operations (mainly hogs).

The decrease in feedlot area is significant in terms of potential pollution sources although the total area is small. Gross erosion on feedlot has been estimated to be 35.5 tons per acre, the highest erosion rates of any of the fourteen land use/cover category (Table 11). This decrease in feedlot area does not equate to a decrease in the number of livestock operations, instead the livestock operations are moved out of the feedlot or woodland areas and into a confinement system (farmstead).

Potential gross erosion significantly decreases between existing conditions and the two projected management scenarios. There is a 47.8% decrease in potential gross erosion from the existing condition (9.0 T/A/Y) to the attainable condition (4.7 T/A/Y). The decrease in potential gross erosion from the existing condition (9.0 T/A/Y) to the future condition (3.0 T/A/Y) is 66.6%. There was a significant shift in the percent of total erosion by different crop rotations between conditions. Three crop rotations account for 65.7% of estimated erosion under existing conditions; these are: 1) corn-soybean (31.5%), 2) corn-corn-soybean (11.1%), and 3) continuous corn (23.1%). The same three crop rotations account for 56.3% and 54.6% of estimated erosion under attainable and future conditions, respectively.

Table 15. Acres, total erosion, total conservation costs by land use/cover for the three specified management scenarios.

Land Use/ Crop Type	EXISTING CONDITION No. of Acres	Total Erosion (Tons)	Total Cost ($)	ATTAINABLE CONDITIONS No. of Acres	Total Erosion (Tons)	Total Cost ($)	FUTURE CONDITIONS No. of Acres	Total Erosion (Tons)	Total Cost ($)
C-S	760.2	19784.5	6385.68	447.6	4463.9	3531.56	342.7	1742.1	3176.83
C-C-S	315.5	6946.1	2524.00	315.5	2702.2	4716.73	258.9	1942.6	10568.30
Continuous Corn	931.7	14545.3	11180.40	1163.8	11203.9	14582.41	1117.1	7617.5	29212.17
C-S-G	129.5	1927.3	3133.90	217.4	1509.6	5789.36	238.9	1040.3	13103.67
C-S-G-M	466.1	4023.8	3169.48	410.0	1861.4	2677.30	456.3	1301.3	6265.00
C-S-G-M-M-M	601.3	4378.3	3968.58	616.8	2881.0	4527.31	688.1	1917.8	14883.60
C-S-G-M-M-M-M	756.3	4389.4	12872.23	759.7	2951.5	8551.87	792.2	2217.9	32907.99
Past/Hay 80% Cover	731.3	1407.4	555.79	497.5	1025.8	39800.00	83.0	114.3	6640.00
Past/Hay 95% Cover	788.0	232.7	10771.96	1061.7	333.7	39240.43	1546.5	566.0	85660.64
Woodland-Managed	543.6	306.5	70021.12	647.8	374.1	88994.76	811.3	476.5	106101.81
Woodland-Unmanaged	266.4	2367.6	-0-	164.9	1439.2	17103.43	1.4	4.8	-0-
Wildlife	311.7	116.5	31372.61	283.9	106.9	38195.91	283.9	106.9	38195.91
Farmstead	109.1	118.3	-0-	109.1	118.3	9252.77	109.1	118.3	9252.77
Feedlot	65.5	2323.4	43589.60	50.7	1656.3	147841.20	46.8	1551.0	131874.44
Water	126.4	-0-		236.4	-0-	-0-	236.4	-0-	-0-
TOTAL	7012.8	62867.3	$199,545.35	7012.8	32627.6	$434,805.04	7012.8	20717.3	$487,843.13

C: Corn; S: Soybean; G: Grain; M: Meadow

Figure 5

BLUECREEK NET VALUE
(PRODUCTION VALUE - TOTAL COST)

A
EXISTING

B
ATTAINABLE

C
ULTIMATE

- > $600 LOSS/ACRE
- LOSS > $300 AND < $600 /ACRE
- LOSS > $200 AND < $300 /ACRE
- LOSS > $100 AND < $10 /ACRE
- LOSS > $10 AND < $100 /ACRE
- LOSS < $10 /ACRE
- NET VALUE < $10 /ACRE
- NET VALUE > $10 AND < $100 /ACRE
- NET VALUE > $100 AND < $200 /ACRE
- NET VALUE > $200 AND < $300 /ACRE
- NET VALUE > $200 AND < $600 /ACRE
- NET VALUE > $600 /ACRE
- NET VALUE = $0 /ACRE

There does not appear to be significant variation in the erosion patterns exhibited by the three scenarios (Figures 3). Correlating Figure 1 with Figures 3 and 4 shows that feedlots and areas under crop production have the highest erosion rates (Table 11). It cost $14.38/ton to reduce the existing conditions erosion rate to the attainable conditions. It cost $40.96/ton to go from the attainable to the future condition. This results from the 100% increase in terrace systems between the conditions and the increase in the number of animal waste systems implemented. To reduce existing watershed mean erosion from 9.0 T/A/Y to the attainable condition's 4.7 T/A/Y, it costs an additional $63.84/ac. To reduce the existing watershed condition's mean erosion to 3.0 tons/ac, it would cost an additional $71.64/ac. It costs an average of $13.83/ac under the attainable conditions, and $28.28/ac to treat the cropland under future conditions. If the present distribution restrictions on ACP Special Water Quality funds within the watershed were eliminated and landowner participation is not a limiting factor, 94% of the watershed could be brought to the attainable condition and 84% under ultimate conditions with the funds available.

The lake sedimentation survey (Bogner, 1979) determined that 38,576 tons of sediment had been deposited in the lake in 18.3 years. This means that the annual rate of lake capacity lost to sedimentation is 1.08% per year. At this rate, Lake Pittsfield would be completely filled in 92 years. However, under attainable conditions only 21,828.58 tons would be delivered to the lake and 20,300 tons would be deposited in Lake Pittsfield itself. This is a reduction of 47%. Under this condition, the rate of depletion of original storage would be reduced to 0.57% per year. Therefore, the life of the lake would be extended to 143 years, a gain of 51 years.

Under future conditions 13,980.98 tons of sediment are transported and 13,002 tons deposited in Lake Pittsfield. The amount of sediment deposition would be reduced by 66%. By implementing long term conservation practices, the annual rate of lake capacity lost to sedimentation is reduced to 0.36% per year, meaning that the life of the lake would be extended 222 years.

It should be noted, however, these numbers are only valid if ultimate or attainable conditions are put into practice immediately, and if the sediment delivery ratio and trap efficiency of the lake remains constant. Sediment delivery ratio may change with the different source areas. Maximum reductions will occur if contributing areas are treated. As noted earlier, a substantial reduction is the amount of sediment delivered to a stream may result in a compensatory increase in channel erosion. Channel erosion produces sediment that is immediately available to the transport system, whereas sediment from cropland must first get to the stream before it can be transported. Changes in the trap efficiency are likely as sediment accumulates within the lake thereby decreasing lake storage volume and lowering residence time.

Conclusions

Although these results are tentative and include many assumptions about costs and revenue information, it is felt that the magnitude of change in the number of land management units producing negative net production values between scenarios is sufficient to show the need for cost share funds for major contributing areas. These findings do not indicate that the total long term benefits from conservation practices will not exceed initial cost. On the contrary, Haith (1979) suggests that the implementation of conservation practices will either have a positive effect or no impact upon crop yields. Current research on crop yields in response to RMS implementation is concentrated in two areas; 1) erosion effects on crop yields, and 2) effectiveness of RMS's on erosion reduction.

Structural practices are expensive to the landowner or operator, even when the government shares in the cost. This expense deters landowners from installing practices. Present government assistance programs (technical and financial) provide incentives for landowners to install practices. If indirect off-site costs (damages), private and public resulting from soil erosion were considered, it would make the implementation of conservation practices more economically attractive for society. Further analysis should yield methods by which cost-sharing could be made more efficient, particularly for targeting cost-share programs for water quality goals instead of just control of soil erosion.

Soil erosion can be reduced to below tolerance limits with the implementation of the prescribed conservation practices, but the true cost and impacts upon water quality were not determined. Clearly, a more detailed, intensive study is needed to assess the true costs and impacts.

This study also demonstrates how the ADAPT system provides a way for estimating program costs and the need for cost-share funds. In addition to this, it also provides a way to test and compare alternative management strategies at the field scale.

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Appendix Section

APPENDIX A

"C" FACTORS FOR ROW-CROP FIELDS

Cropping System	TILLAGE SYSTEM								
	Mold. Plow-Spring	Mold. Plow-Fall	Chisel Plow 1-2000# RES	Chisel Plow 2-3000# RES	Chisel Plow 3-4000# RES	No-till 1-2000# RES	No-till 2-3000# RES	No-till 3-4000# RES	No-till 4-6000# RES
C-Sb	.43	.48	.32	.21	.16	.29	.16	.11	.06
C-C-Sb	.40	.44	.31	.21	.16	.29	.16	.11	.06
Continuous Corn	.37	.40	.31	.20	.12	.29	.16	.11	.06
C-Sb-Gr	.30	.33	.24	.17	.13	.15	.11	.09	.08
C-Sb-Gr-M	.16	.18	.15	.13	.11	.11	.08	.06	.05
C-Sb-Gr-M-M-M	.10	.12	.10	.08	.07	.07	.05	.04	.03
C-Sb-Gr-M-M-M-M-M	.08	.09	.08	.07	.06	.06	.04	.03	.02

Note: C-Sb calculated as average of continuous corn and continuous soybeans.

APPENDIX B

"P" FACTORS FOR ROW-CROP FIELDS

% Slope	CONSERVATION PRACTICE						
	NO PRACTICE	CONTOURING	TERRACES	STRIP-CROPPING	PASTURE/CRITICAL AREA SEEDING	LIVESTOCK EXCLUSION	ANIMAL WASTE SYSTEM
≤1.0	1.0	0.60	0.60	0.45	1.0	1.0	1.0
1.1-2.0	1.0	0.60	0.60	0.45	1.0	1.0	1.0
2.1-7.0	1.0	0.50	0.50	0.40	1.0	1.0	1.0
2.1-12.0	1.0	0.60	0.60	0.45	1.0	1.0	1.0
12.1-18.0	1.0	0.80	0.80	0.60	1.0	1.0	1.0
18.1-24.0	1.0	0.80	0.0	0.70	1.0	1.0	1.0
>24.0	1.0	1.0	1.0	0.80	1.0	1.0	1.0

APPENDIX C

"C" AND "P" FACTORS FOR NON ROW-CROP FIELDS; SLOPE LENGTH DATA

"C" Factors

LAND USE TYPE	"C"
Pasture/hayland -- 80% Ground Cover	0.013
Pasture/hayland -- 95% Ground Cover	0.003
Woodland -- Managed	0.003
Woodland -- Unmanaged	0.042
Wildlife	0.003
Farmstead	0.011
Feedlot	0.450

"P" Factors

"P" factor for non row-crop fields is 1.0 under all slope conditions

SLOPE LENGTH

Slope length is a function of soil type except in cases where row-crop fields use terracing. In those cases, the following slope lengths apply:

SLOPE	TERRACE LENGTH
<5%	150 feet
5-10%	120 feet
>10%	90 feet

TED:sd/sp/3273c/1-38